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David K. Aylward

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August 8, 1997

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

William F. Caton
Acting Secretary
Federal Communications Commission
Room 200
1919 M Street, N.W.
Washington, DC 20554

Re: Notice of Ex Parte Communication
CC Docket Number 94-102

Dear Mr. Caton:

Yesterday, representatives from TruePosition, Inc., a subsidiary of The Associated Group, Inc. met with John Cimko, Chief, Policy Division of the Wireless Telecommunications Bureau. Also attending the meeting from the Wireless Bureau were Nancy Boocker, Dan Grosh, Won Kim, and Ron Netro. Representing TruePosition at the meeting were Kent Sander, Louis Stilp as well as the undersigned.

At the briefing, we discussed the operational and quantitative benefits from New Jersey's first-in-the-nation live trial of a Phase II location system sponsored by TruePosition. We also presented Mr. Cimko and his staff with a detailed report (attached) of the specific findings of the trial from New Jersey's Attorney General. Further, we presented a list of minor clarifications to the Commission's Report and Order and Further Notice of Proposed Rulemaking, also attached for the record, that would help create greater certainty to the Order.

In accordance with section 1.1206 of the Commission's rules we have attached two copies of each of these documents. If you have any questions regarding this correspondence, please feel free to contact me at your convenience.

Sincerely,

David K. Aylward

David K. Aylward

CC: John Cimko

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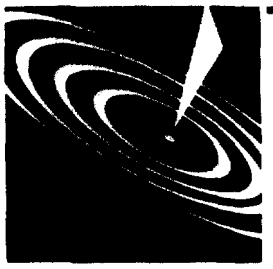

TruePosition™

August 7, 1997

Mr. John Cimko
Chief, Policy Division
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M St., N.W.
Washington, D.C. 20554

Re: Ex Parte: CC Docket No. 94-102

Dear Mr. Cimko:

TruePosition commends the Commission for its foresight and leadership in addressing wireless E9-1-1 issues. Based on this Order, over the next several years, wireless carriers and state and local governments will make significant investments in wireless location technology and systems to provide accurate location identification. The policy goal has been established. The questions before the Commission now are details, and how to encourage the rapid implementation of its Order.

TruePosition, Inc., a subsidiary of The Associated Group, Inc., is a manufacturer of an automatic location system for wireless telecommunications subscribers. The TruePosition Wireless Location System can locate wireless 911 callers without requiring any changes to existing handsets, for which the installed base is now approximately 50 million. TruePosition operates only by adding technology to the wireless carrier's network. The TruePosition system, which relies on time-difference-of-arrival (TDOA) technology, can fully comply with Phase II of the Commission's Report and Order today. TruePosition has been successfully demonstrated in recent live trials in Houston, Texas and southern New Jersey.

Based on extensive field testing of location technology, TruePosition has demonstrated that commercial technology exists today to meet both Phase I and Phase II of the Commission's Order. The New Jersey Attorney General's and Office of Emergency Telecommunications Services' (OETS) report on a test of the TruePosition system, "*The First 100 Days*", states:

> "Based on testing from January 22 to April 30, 1997, OETS has concluded that the system trial was extremely successful in demonstrating that commercial technology exists to meet the needs of the FCC's Phase I and Phase II in New Jersey and elsewhere. This conclusion is based upon over 3,500 live calls received, and over 81,000

The Associated Group, Inc. • Three Bala Plaza East • Fifth Floor • Bala Cynwyd, PA 19004 • (610)660-5240 • Fax (610)660-5202

81,000 test calls placed by participants in the trial."[1]

I. SUMMARY

The primary barrier to full deployment of wireless location technology is uncertainty. Carriers will be hesitant to make the significant investments required to install location technology if they believe the fundamental goals may be changed. There are two critical areas where this can occur: accuracy and date of compliance. The ironic danger of progress such as TruePosition has just demonstrated is that some may argue that the accuracy requirement should now be increased, or the compliance date accelerated. Either would be destructive of the Commission's goal, just as going to the other extreme of delaying the compliance date would be.

The most important action the Commission can take to encourage the rapid implementation of wireless E-9-1-1 is to make it clear it will not change the fundamentals of the Order.

In addition, there are several much smaller issues raised in the Report and Order which contribute to uncertainty, and thus to reticence in making investment decisions. TruePosition believes that some minor clarifications in the Report and Order would solve these problems. The suggested clarifications to the Report and Order reflect the specific comments that wireless carriers, state and local officials, and PSAPs have communicated to TruePosition, as well as our "real world" experience during the 100 day field trial in New Jersey.

We discuss four separate issues.

- In Phase II systems, calls should be routed by caller's location. The Order is currently silent on this question.
- Demonstration of location system accuracy should be through controlled testing. The Order is currently silent on the type of testing which will suffice. The New Jersey field test experience makes it clear that controlled testing is far superior to trying to measure the accuracy of actual emergency calls.
- The rules should state that the accuracy requirement is 125 Meters for 67% of 911 calls. The Report and Order is confusing in that it sometimes uses this measure. Other times it uses Root Mean Square; and sometimes it uses both. This has significant system design implications.
- Flexibility in achievement of 67% point may be needed. This may be important for rapid deployment in rural areas.

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[1]Report on the New Jersey Wireless Enhanced 9-1-1 System Trial January 22 1997 to April 30, 1997, *The First 100 Days*. State of New Jersey Department of Law and Public Safety, Office of Emergency Telecommunications Services. June 16, 1997. Page 5. (Attached for the record).

II. ESTABLISHING CERTAINTY FOR LOCATION TECHNOLOGY INVESTMENTS

A. Do Not Change The Goals Of The Report And Order

While TruePosition would benefit from advancing the implementation date, we believe it will be counterproductive for the Commission or others to send carriers the message that "the goal posts will be moved" every time there is some new technical solution, progress, or problem developed in the marketplace. Changing the target will freeze corporate decision making and it will not allow the marketplace to work.

Thus, we believe the Commission should explicitly determine that it will not pursue such "improvements", some of which were suggested in the Commission's Further Notice of Proposed Rulemaking. TruePosition submits that there will be greater benefits extended to the public by focusing first on initial implementation issues of the Report and Order, rather than creating additional uncertainty by proposing additional advancements addressed in the Further NPRM. The Commission wisely did not select a particular location technology, or impose a particular financial structure. Questions such as cost, technical feasibility, improvements in location estimate accuracy, and periodic updating of caller information will be advanced by competition among carriers and vendors in the marketplace. Additional Commission intervention will have the likely effect of delaying investment.

B. Certainty Issues Left To Other Decision Makers

The primary issues standing in the way of commercial deployment are financial arrangements between carriers on the one hand and state and local governments on the other, along with a handful of significant state regulatory issues (e.g. extending limited liability, or Good Samaritan, laws to wireless carriers and location providers). The Commission has left these issues to others to decide, but it can and should encourage them to do so.

III. IN PHASE II SYSTEMS, CALLS SHOULD BE ROUTED BY CALLER'S LOCATION

During the recent live trial of TruePosition's wireless E9-1-1 system, calls were routed to the appropriate PSAP using the caller's location when the caller was in the Phase II coverage area of the trial. Callers outside or on the fringes of the trial network could not be located, but Phase I data was provided and the caller was routed to PSAPs based on the originating cell site and sector. When calls were routed by this Phase I methodology, calls were inappropriately routed approximately 30% of the time (because the cell sector geography did not match PSAP jurisdictional lines). In areas where cell sites cover even more PSAPs than in our test area, state officials estimated that the percentage of inappropriate routing could be much higher.[2]

The Report and Order does not specifically address whether routing in Phase II should be done as it is in Phase I, or based on the caller's location. TruePosition recommends that the FCC clarify that in Phase II systems, wireless 911 calls be routed to appropriate PSAPs based upon the caller's location. In Phase II, the location information is already available; it is a minor step to also route on the caller's location information.

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[2]Id 1, Page 32.

IV. DEMONSTRATION OF LOCATION SYSTEM ACCURACY SHOULD BE THROUGH CONTROLLED TESTING

PSAPs and wireless carriers need to know what type of testing is acceptable to demonstrate that a wireless 911 location system is in compliance with the Report and Order. Currently, language from the Report and Order does not describe how accuracy should be demonstrated:

> "A covered carrier shall be required to demonstrate, upon request made by the PSAP, that its ALI system performs in compliance with the requirements established in the Order."[3]

TruePosition, as the first wireless location system to undergo live trials, now has significant field experience in demonstrating location system performance. This experience has been shared by Greater Harris County 9-1-1, the State of New Jersey, Comcast Cellular, and other large telecommunications companies that have participated in field testing of the TruePosition system. The relevance of this "real world" experience to the type of testing which should be undertaken is fully explained by the New Jersey E-9-1-1 Report. TruePosition endorses the New Jersey suggestion that controlled testing be the approved method of determining accuracy:

> "The accuracy of the wireless location system was measured through extensive testing. Before the initiation of the trial, OETS had planned to measure the accuracy of the system by requesting PSAP operators and public safety telecommunicators to use an electronic map terminal to compare a caller's TruePosition-calculated location with the caller's actual location as reported verbally during the call. However, two problems were encountered with this planned testing methodology. During emergencies, public safety telecommunicators are heavily engaged in responding to the emergency (i.e. gathering critical details, dispatching and routing ambulances, coordinating resources) and frequently do not have the time to record trial information before the next emergency call arrives. Second, people involved in an emergency have difficulty explaining their exact location in sufficient detail to make a meaningful estimate, which is, after all, the reason we need the new technology in the first place. A typical verbal estimate might be "a quarter mile past the Route 30 overpass", which is not sufficient to verify a 410-foot accuracy requirement.
>
> "Therefore, all participants in the trial adopted a testing approach that involved organized drive testing of the system. The location system was configured such that it would locate both wireless E9-1-1 callers and phones identified as test phones. Various test points along the New Jersey Turnpike, I-295, as well as off-highway test points were accurately surveyed using Differential Global Positioning System (D-GPS) receivers. In excess of 100 separate test points were surveyed in this manner. The drive testing was accomplished by sending drive test volunteers in vehicles to the test points, where the volunteers would place test calls. Between 1 and 100 test calls might be placed at various test points during each day of drive testing, depending on the test objective for the day. The system recorded the calculated locations of the test calls into a database for analysis. In addition to the test calls placed during drive testing, the TruePosition development team placed test phones at fixed sites throughout the trial area. These phones were automatically located approximately every 10 to 15 minutes as a continuous measure of the performance of the location system.
>
> "Additional testing was conducted by other parties including Comcast, OETS staff, the E9-1-1 Public Safety Agencies of Salem, Gloucester, and Camden counties, and a large, independent telecommunications company, all of which reported similar results.

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[3]Report and Order and Further Notice of Proposed Rulemaking, Adopted June 12, 1996, Released July 26, 1996. FCC 96-264, In the Matter of Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems (CC Docket No. 94-102), Paragraph 71.

"OETS believes that the drive testing described above is representative of the performance of a location system during actual emergency calls. The participants monitored the profile of actual emergency calls, and concentrated testing in those areas where the most number of E9-1-1 calls were received. "[4]

TruePosition concurs with the testing methodology described above, and recommends that the Commission clarify that controlled testing based on the pattern and volume of actual E9-1-1 calls will meet the requirements of the Report and Order, and that additional details such as the specific structure of tests, the number of test calls, and the frequency of testing shall be left to local carriers and PSAPs in the carrier's service area.

V. RULES SHOULD STATE ACCURACY REQUIREMENT IS 125 METERS FOR 67% OF 911 CALLS

The Report and Order currently defines the accuracy requirement for Phase II of Wireless Enhanced 911 Emergency Calling Systems using several different descriptions. While the descriptions were intended by the FCC to provide a clear and uniform standard by which wireless location systems could be designed, deployed, and measured, there are subtle differences in the various descriptions that impact design and deployment decisions. TruePosition respectfully suggests that the Commission review its intent in defining the accuracy standard, and clarify the exact statistical measure to be used in location system design and deployment. Based upon its substantial efforts in developing location system technology, and in working with many participants during the proceeding of the NPRM, TruePosition believes that the true intent of the FCC was to make the rules state that Phase II systems must "locate all wireless 911 callers, using latitude and longitude data, and that the degree of accuracy be within a radius of 125 meters for 67 percent of the wireless 911 calls processed."

[4]Id 1, Page 20.

A. RMS Is A Different Statistical Measure Than 67 Percent Point

There are many statistical measures by which a data set can be evaluated, including the data generated by a 911 location system. One classical statistical measure is known as Root Mean Square, or RMS. The exact form of equation is provided in the Public Safety –Wireless Industry Consensus, Wireless Compatibility Issues[5]. Using this equation,

(1) each element in the data set is first squared;
(2) then the average (or mean) of the squared values is calculated;
(3) then the square root of the average (or mean) is calculated.

An example of this process is shown below for a small data set.

	Elements			Squared Elements	
1)	343	x 343	=	117649	
	131	x 131	=	17161	
	492	x 492	=	242064	
	217	x 217	=	47089	
	380	x 380	=	144400	
	609	x 609	=	370881	
2)		Average	=	156541	
3)		Root Mean Square	=	√156541	= **395 Feet**

Another statistical measure of data sets is reporting a specific percentile. For example, the 50% point of a data set is the value in the data set at which exactly half of the elements are below the value at the 50% point and half of the elements are above the value at the 50% point. Most everyone is familiar with the percentiles reported for standardized tests given in most schools. As another example, the IRS recently reported aggregate Adjusted Gross Income levels for 1995 returns at the 50% point, 90% point, and 99% point. The method for the 67% point is:

(1) order all of the elements in the data set from smallest value to largest value;
(2) select the value in the data set that is 67% of the way down the list of elements.

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[5]Public Safety –Wireless Industry Consensus, Wireless Compatibility Issues, CC Docket 94-102, filed February 12, 1996, Appendix C.

$$\text{Root Mean Square} = \sqrt{\sum_{i=1}^{i=n} \frac{(X_a - X_{ei})^2 + (Y_a - Y_{ei})^2}{n}}$$

Where a = 2-dimensional actual location in X (longitude) and Y (latitude)
ei = 2-dimensional estimated location in X and Y, and
a-ei = linear error between actual and estimated location, and
n = number of elements in the data set

An example of this process is shown below, using the same data set as for the earlier RMS example.

(1) 131
217
343
380
492
609

(2) 67% point is 4/6 down the list = **380 Feet**

Measurement of percentile is just as popular a statistical measure as RMS; however, the two processes do yield different results. As the discussion in the Consensus Agreement shows, the RMS value of a data set can contain as little as 63% of the data elements, and as much as 75% of the data elements.[6] The exact percentile defined by RMS can vary from data set to data set and from design to design. Also, the RMS value of a data set can be higher or lower than the value at the 67% point.

B. Apparent Intent Of Commission Was To Make The Accuracy Requirement 125 Meters, 67% And Not 125 Meters RMS

Because of this great variability, TruePosition believes that the FCC intended to select a fixed percentile, namely the 67% point, as the single statistical measure so that the emergency 911 community could be certain of the level at which all location systems would perform. This intention seems clear from the FCC's Press Release on June 12, 1996, and in the discussion in various sections of the Report and Order:

> "Within five years after the effective date of the rules, the location of the mobile station must be provided to the PSAP in two dimensions, with an accuracy within a radius of 125 meters in 67 percent of all cases."[7]

> "Under Phase II, not later than five years after the effective date of the rules adopted in this proceeding, covered carriers are required to achieve the capability to identify the latitude and longitude of a mobile unit making a 911 call, with a radius of no more than 125 meters in 67 percent of all cases."[8]

6Public Safety –Wireless Industry Consensus, Wireless Compatibility Issues, CC Docket 94-102, Page 2: "...this level of accuracy was achieved 70-75% of the time. If the curve plotted from the results were 'normal' (Gaussian), statistical theory holds that RMS distance would represent 63 to 68% probability of containment within an area around true position – depending on whether the area were more nearly circular or elliptical. Thus, roughly speaking, to prescribe '125 meters RMS' is to require that degree of ALI accuracy from two-thirds to three-fourths of the time."

[7] FCC Press Release June 12, 1996, "FCC Adopts Rules To Implement Enhanced 911 For Wireless Services (CC Docket No. 94-102)," Paragraph 3.

[8] Id 3, Paragraph 10, Page 8.

"Based on the present record, we have adopted requirements under which carriers must supply to PSAPs, not later than five years after the effective date of the rules adopted in the Report and Order, information that locates a wireless 911 caller within a radius of 125 meters, using latitude and longitude data, and that provides this degree of accuracy for 67 percent of the 911 calls processed."[9]

However, the definition seems less clear in another part of the Order as the two different statistical measurement processes are combined together:

"In light of these considerations, we adopt a requirement pursuant to which covered carriers must achieve the capability to identify the latitude and longitude of a mobile unit making a 911 call, within a radius of no more than 125 meters in 67 percent of all cases. The degree accuracy shall be calculated through use of Root Mean Square methodology."[10]

Finally, in light of the above discussion, the words appearing in the Final Rules are not consistent with the Press Release nor the discussion in the Report and Order:

"As of [five years after the effective date of this rule], licensees subject to this section must provide to the designated Public Safety Answering Point the location of a 911 call by longitude and latitude within a radius of 125 meters using root mean square techniques."[11]

The differences between RMS measurement and 67% point measurement may seem arcane and trivial to most observers, but it can have an effect on the manner in which location systems are designed and deployed. For example, a system designed for a particular city may require 40 location receivers for an RMS design, but 45 receivers for a 67% point design. In another city, the numbers may actually be reversed: 45 receivers for RMS and 40 receivers for 67% point. It could become a point of confusion and contention if a wireless carrier insisted on one statistical measure for designing a location system while the emergency 911 provider insisted on another statistical measure for evaluating the carrier's compliance with the Report and Order.

For these reasons, TruePosition respectfully requests that the FCC clarify its intention and adopt a single set of language defining the accuracy requirement for Phase II. Specifically, TruePosition recommends that the language state that Phase II systems "locate all wireless 911 callers, using latitude and longitude data, and that the degree of accuracy be within a radius of 125 meters for 67 percent of the wireless 911 calls processed." This would achieve the goal of providing the 911 community with a single, quantifiable percentile for all location system designs.

VI. FLEXIBILITY IN ACHIEVEMENT OF 67% POINT MAY BE NEEDED

Wireless E9-1-1 will be largely implemented at the state and local level, and some carriers, PSAPs, and public officials have raised new ideas about how best to meet Commission standards for

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[9]Id 3, Paragraph 136, Page 68.

[10]Id 3, Paragraph 71, Page 37.

[11]Id 3, Appendix C, Final Rules, Part 20 of Title 47 of the Code of Federal Regulations, Section 20.18 911 Service, part(e).

their individual systems. TruePosition does not specifically endorse these ideas or any weakening of FCC requirements, but the ideas do warrant discussion.

In the live field trials, it was learned that the placement of location receivers can have a dramatic effect on the distribution of location errors. The specification of location error as "having a radius of no more than 125 meters in 67% of all cases" is a specification type known as Circular Error Probability (CEP), which implies that the error distribution is in a circular fashion. The error distribution of a location system is greatly affected by the geometry of the location system receivers relative to the location of the wireless 911 caller, and in many cases, the error distribution is an ellipse. For example, in the New Jersey trial, the TruePosition system was deployed in a long, narrow corridor, which resulted in an error distribution for each test point that was usually an ellipse. In one set of tests, the average ratio of the short side of the ellipse (minor axis) to the long side of the ellipse (major axis) was 1 to 1.75, which is a relatively flat ellipse.

The New Jersey report described this observation in terms of a "parallel" component of error and a "transverse" component of error, which is roughly equivalent to the minor axis and major axis of the ellipse. For example, in Zone 1 of the test area, which was largely rural, the aggregate error (CEP) was 515 feet at the 67% point, but the parallel error was 355 feet and the transverse error was 433 feet.[12] This is a ratio of 1 to 1.22, which is a moderate ellipse. Note that the area of this ellipse is actually 9% smaller than the area of a 410 foot circle[13], which means that the search area is smaller.

In many places in this country, it may be quite acceptable for the location system design to result in an elliptical distribution of location estimates. For example, in rural areas that have a only few major roads, an elliptical distribution can be very accurate parallel to roads (minor axis), and less accurate transverse to roads (major axis). This would allow emergency personnel to quickly find the section of a road at which an accident occurred, but it may be more ambiguous whether the emergency was on the road itself or in an adjacent field. But in rural areas, it is usually very easy for emergency personnel arriving at a scene to find someone within 500 feet or even 1,000 feet. Since accidents usually happen on roads, the ambiguity of the location system is offset by common sense and verbally questioning the victim whom cannot identify the section of road, but does know it is a road and not a field.

There is one simple reason why a local carrier or emergency organization would be willing to accept an error distribution different than that specified by the Commission: cost of the location system. The deployment of more location receivers can shape error distribution into a circular shape, but in rural areas where cell sites are deployed in linear fashion along highways, more location receivers may require more receiver sites at places other than cell sites.

Therefore, the Commission is asked to consider whether a clarification of rules is warranted that would (1) retain the Phase II accuracy requirement to be within a radius of 125 meters for 67 percent of the wireless 911 calls processed, but (2) permit local PSAPs, emergency authorities, or government agencies to balance the requirement against deployment cost. While the waiver process is always available as one mechanism, TruePosition suggests that this would be extremely burdensome to both the

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[12]Id 1, Page 26.

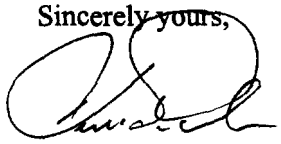
[13]The area of an ellipse is (ab), where 'a' is the minor axis and 'b' is the major axis. The area of a circle is (r^2), where 'r' the radius of the circle.

Commission and PSAPs.

VI. Conclusion

We appreciate this opportunity to share our views with you, and look forward to working with the Commission in the months ahead. Please feel free to call on us if you have any questions about the foregoing.

Sincerely yours,

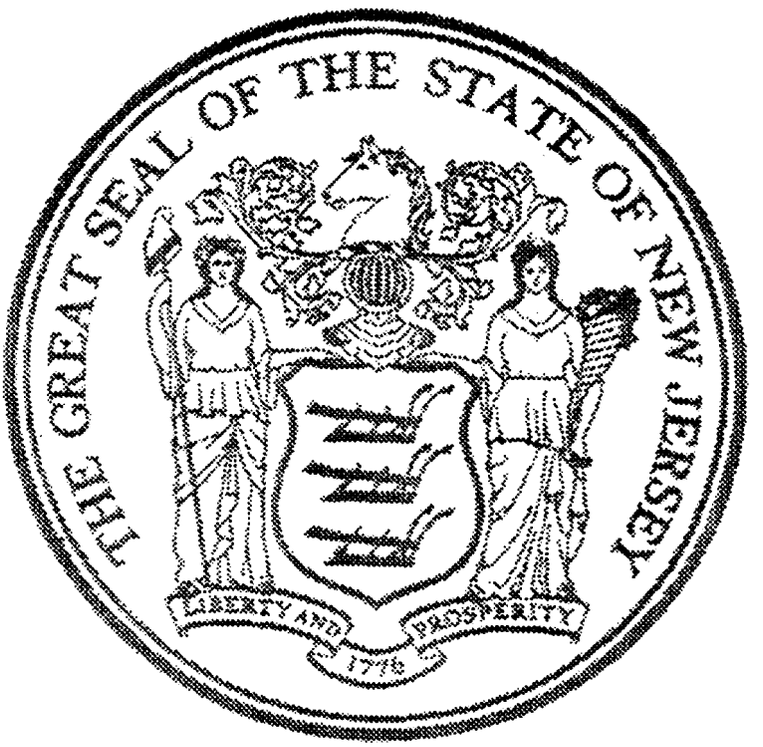


Kent Sander
President and Chief Operating Officer

Attachment

Report On The New Jersey Wireless Enhanced 9-1-1 System Trial January 22 to April 30, 1997

The First 100 Days



State of New Jersey
Department of Law and Public Safety
Division of State Police
Colonel Carl A. Williams, Superintendent
Office of Emergency Telecommunications Services
S. Robert Miller, Executive Director

Christine Todd Whitman
Governor

Peter Verniero
Attorney General

June 16, 1997

State of New Jersey

DEPARTMENT OF LAW AND PUBLIC SAFETY
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CN 080
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CHRISTINE TODD WHITMAN
Governor

PETER VERNIERO
Attorney General

June 16, 1997

I am pleased to release the report entitled "The First 100 Days", detailing the results of New Jersey's first in-the-nation live trial of Wireless Enhanced 9-1-1 technology. This trial had an immediate impact on improving public safety. The findings from the trial represent significant progress in our efforts to quickly locate emergencies after a wireless caller dials 9-1-1. They prove that the commercial technology exists and can be deployed to meet the Federal Communications Commission's Wireless E9-1-1 Report and Order in Docket No. 94-102.

The State of New Jersey took the lead in conducting the nation's first live trial utilizing wireless location technology. The cooperation between the State of New Jersey, county governments, emergency personnel, and the private sector demonstrated a partnership model that can be replicated to provide enhanced wireless 9-1-1 service across the State and throughout the country.

Over an area of 350 square miles in southern New Jersey, where the location technology was deployed, our Public Safety Answering Points (PSAPs) were quickly able to pinpoint the location of over 3,500 wireless callers. Dispatchers had to stay on the phones for far less time with each individual caller, and even callers with no recognizable landmarks in sight were easily and quickly located. This meant that multiple dispatch units did not need to be sent to callers who could not describe their location, and accidents which received many calls from passing motorists could be easily identified as one incident. Most important, response units were able to arrive at emergency scenes much more quickly to aid victims. Overall, this new system was extremely efficient in helping 9-1-1 callers.

We hope that the findings and recommendations in this report will help expedite the full and rapid deployment of wireless E9-1-1 location technology. With more than 46 million wireless subscribers in the U.S. and 60,000 wireless calls to 9-1-1 being made each day, and both increasing rapidly, the need for a nationwide wireless 9-1-1 location system grows every day.

Sincerely yours,

Peter Verniero
Attorney General

Table of Contents

Mission Statement of the New Jersey Office of Emergency Telecommunications Services (OETS)

The New Jersey Office of Emergency Telecommunications Services (OETS), in consultation with the telephone companies and the Board of Public Utilities and with the assistance of the Office of Telecommunications and Information Systems in the Department of Treasury, has the responsibility to plan, design, coordinate and implement the statewide 9-1-1 (enhanced) telephone system.

Executive Summary

Background Wireless calls to E9-1-1 Public Safety Answering Points (PSAPs) have significantly improved public safety. However, because of call volume and the time it can take for emergency personnel to determine the location of the caller, they have created new challenges. Unlike wireline calls to E9-1-1, there is no information, such as a callback number or the caller's location, available to E9-1-1 operators for answering wireless calls. Frequently, wireless callers do not know their exact location, especially at night when surroundings are unfamiliar and the trauma of an accident or other emergency reduces cognizance. Therefore, in July, 1996, the FCC issued a Report and Order designed to address these problems. FCC Phase I provides for callback number and originating cell site to be reported to E9-1-1 operators. Phase II provides for the callback number and the caller's location (generally within 410 feet).

Launch On January 22, 1997, only 6 months after the FCC Report and Order, the New Jersey Office of Emergency Telecommunications Services (OETS) launched the first live wireless enhanced 9-1-1 trial in the United States. The trial, using the Comcast Cellular Communications system, covered a 50 mile corridor of the New Jersey Turnpike and I-295 through Salem, Gloucester, Camden, and Burlington counties, and employed new and developing technology from a number of companies including: TruePosition, SCC Communications, Rockwell Telecommunications, KML Technologies, and others. The trial focused on the most popular type of wireless telephone in the country - cellular AMPS-based telephones.

Objectives The primary objective of the New Jersey Wireless Enhanced 9-1-1 System trial was to determine whether commercial technology exists today to meet New Jersey's wireless 9-1-1 requirements and those of the FCC Report and Order. Since the technology was literally brand-new and developing, OETS also wanted to determine (i) whether changes would be required to move from technology trial to full operational systems, (ii) what technical system integration challenges must be faced, (iii) whether the trial would have any impact on the existing New Jersey 9-1-1 network, and (iv) whether E9-1-1 operators would see significant value in having technology like this at their disposal.

Results Based on testing conducted from January 22 to April 30, 1997, OETS has concluded that the system trial was extremely successful in demonstrating that commercial technology exists to meet the needs of the FCC's Phase I and Phase II in New Jersey and elsewhere. This conclusion is based upon over 3,500 live wireless 9-1-1 calls received, and over 81,000 test calls placed by participants in the trial. The wireless 9-1-1 location system was demonstrated on multiple days at multiple test points on calls by multiple independent test participants and proves its ability to meet the FCC Phase II requirement of 410 feet, 67% criteria. OETS also concluded the system was extremely valuable to E9-1-1 operators, and that the impact on the existing network was minimal. Most importantly, OETS concluded that its everyday use made emergency response so routine that sensational 'search and rescues' like that involving a woman stuck in the snow for 40 hours in South Dakota never happened. The testing also identified changes required when upgrading from technology trial to full state-wide operations. For example, test points achieving the 410 feet requirement were in areas of good location system coverage. The overall system average was approximately 600 feet, but this can be lowered to or below 410 feet by upgrading the system coverage to the level used in the successful areas.

I. Wireless E9-1-1 Background

A. Increasing Usage of Wireless Expands the Need for Enhanced 9-1-1

The first cellular system in the country was turned on in 1983. Today, there are over 46 million wireless subscribers (approximately 96% using cellular AMPS-based telephones) -- representing almost 20% of the U.S. population. With so many persons carrying wireless telephones, emergency calls from wireless devices to 9-1-1 have dramatically increased. In 1994, the number of wireless calls per day to 9-1-1 totaled 50,000 nationwide. Last year, the growth of daily emergency wireless calls had reached an estimated 60,000 nationwide. By the turn of the century, this number is expected to top 130,000 calls per day (approaching the number of 9-1-1 calls initiated from wireline networks). Wireless telephones are increasingly used as essential tools in the effort to ensure the broader community's safety, not just for individuals concerned about being able to communicate in emergencies. For example, local crime watch groups across the country, such as Communities on Phone Patrol (COPP) or those in Camden County, use wireless phones to dial 9-1-1 to report incidents and request assistance from local police and rescue units.

As more telecommunications carriers enter New Jersey markets to provide new types of wireless services, lower prices and more competition will mean more usage of wireless phones and, subsequently, more wireless calls to 9-1-1. Wireless 9-1-1 calls represented 43% of all calls to 9-1-1 received at the test area PSAPs during the trial. Across the state, wireless represents a growing proportion of all emergency calls as well.

The growth in wireless use has made a significant contribution to public safety, providing notice of accidents, crimes, and other emergencies more quickly than if only wireline telephones could be used. But because of this increase in wireless 9-1-1 calls, PSAPs throughout New Jersey report an increasing number of challenges that impede their ability to assist people in emergencies. The benefits of E-9-1-1 is lost when PSAPs cannot find these callers.

Wireless calls to E9-1-1 PSAPs have created a new challenge for these operations, both in volume and in the time it takes emergency personnel to respond. Unlike landline calls to E9-1-1, there is no information, such as a callback number or the caller's location, available for wireless calls to E9-1-1 operators. Frequently, wireless callers do not know their exact location, especially at night when surroundings are unfamiliar and the trauma of an accident or other emergency reduces cognizance. Therefore, dispatchers must typically stay on the call longer, attempting to determine the location. When the location cannot be determined, multiple response units must be dispatched to find the caller. It is also common for four to five motorists to call '9-1-1' to report a single accident, all attempting to describe the same location. If the location descriptions are not consistent, dispatchers cannot discern whether there is really just one accident or multiple accidents and may have to play it safe by dispatching multiple units.

Across the country, there have been well publicized incidents in which prompt identification and location of a wireless E9-1-1 caller would have greatly improved response time and increased the chances for reducing injury and saving lives. For example, during a South Dakota blizzard in January, 1997 Karen Nelson of Webster, SD was trapped in her car beneath a snow drift in sub-zero degree temperatures. Her cellular phone saved her life, but it took police and rescue teams over 40 hours to locate her because there was no location technology in place. While some have been more publicized than others, these incidents which happen every week, can be reduced through deployment of wireless location technology.

The typical time a dispatcher spends confirming the location of an enhanced 9-1-1 wireline call is 5-10 seconds. With these calls, the address and call-back number of the calling party is displayed directly in front of the dispatcher, who merely has to confirm the information on wireless calls. Without the new location technology, PSAP dispatchers regularly spend from 30-45 seconds to several minutes on each wireless call. At night, time spent on calls without automatic location technology increases dramatically. One PSAP director in the trial area said, "without location technology, the dispatcher would have to spend time trying to pull-out landmarks from the caller and then in some cases take their best guess."

Without wireless E9-1-1 location technology in place, these factors add up to rising costs for PSAPs and ultimately higher taxes for consumers. Increased wireless use will mean increased 9-1-1 calls from wireless phones. Wireless calls take much longer to process, require greater levels of expertise, and result in much more duplication than wireline emergency calls. If this trend continues, there will have to be larger PSAP facilities, additional trunk lines, more switches, and probably twice as many call-takers. And they will still not know the location of wireless callers.

B. FCC Ruling

The wireless industry, the E9-1-1 community, and the Federal Communications Commission (FCC) began joint efforts in mid-1994 to solve the technological and policy hurdles to providing wireless E9-1-1. In June 1996, the FCC issued a Report and Order in Docket 94-102, formalizing the requirements and implementing a schedule for wireless E9-1-1 emergency calling systems. In so doing, the FCC ordered that implementation and deployment of wireless E9-1-1 features and functions be accomplished in two phases:

Phase I (to be completed by April 1, 1998)

Wireless carriers must report the callback number (also known as Automatic Number Identification or ANI) and originating cell site and/or sector of a 9-1-1 call to requesting 9-1-1 PSAPs.

Phase II (to be completed by October 1, 2001)

Wireless carriers must report the location of all 9-1-1 callers (known as Automatic Location Identification or ALI) with an accuracy of 125 meters (410 feet) for 67% of the callers to requesting 9-1-1 PSAPs.

II. Background of Trial

A. New Jersey's First in the Nation Live Wireless E9-1-1 Field Test

Realizing the importance and need for wireless E9-1-1, New Jersey became the first state in the nation to conduct a live trial of wireless E9-1-1 with location technology. On January 22, 1997 the first wireless E9-1-1 system trial was launched in New Jersey using the Comcast Cellular Communications System and the TruePosition Wireless Location System. The Attorney General of the State of New Jersey, the Chairman of the Federal Communications Commission, and the President of the Cellular Telecommunications Industry Association assisted in the launch. The test included a variety of active test participants, including the New Jersey Attorney General's Office, New Jersey State Police, OETS, and E9-1-1 coordinators from Camden, Gloucester and Salem Counties. The key role of Selective Routing (SR) was provided by Bell Atlantic, Rockwell, and SCC. KML, On-Target Mapping, MapInfo, and QED were responsible for the PSAP terminals and the mapping displays.

Prior to the New Jersey trial, no location system had ever been deployed for wireless telephones over such a large area. The TruePosition Time Difference Of Arrival (TDOA) location system OETS tested had previously been successfully tested in smaller areas of 20 square miles or less, including downtown Philadelphia, Baltimore, and Houston. But additional techniques and functionality were to be attempted to scale the location system from 20 square miles to 350 square miles.

The system was tested from January 22 to April 30, 1997 and located wireless E9-1-1 callers on the southern 50 miles of the New Jersey Turnpike/Interstate 295 corridor, an area of approximately 350 square miles. The TruePosition Wireless Location System was deployed on 24 cellular towers of the Comcast Cellular Communications System and covered portions of four counties: Salem County at the southern end, then Gloucester County, Camden County, and Burlington County on the northern end. The location system as deployed is shown in the picture below:

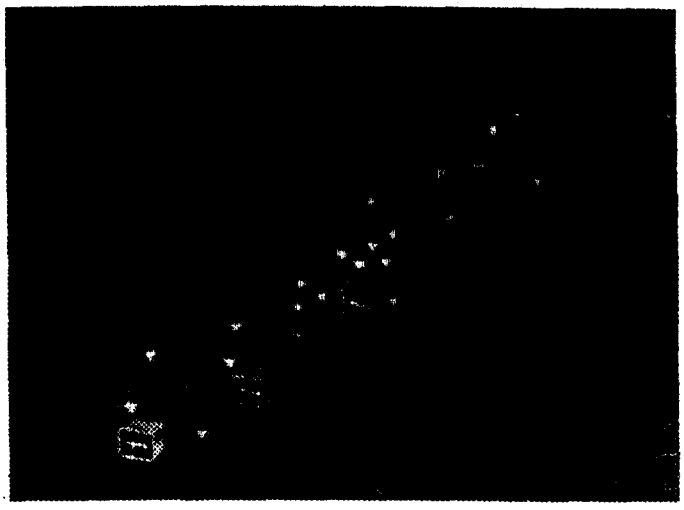

Figure 1 – Location System Coverage – Receiver and PSAP Coverage

Trial Objectives

The objectives of the New Jersey Wireless Enhanced 9-1-1 System trial were to:

- Implement the first operational wide-area commercial location trial using technology from many participants as a first step in reaching Phase II of the FCC's Report and Order.
- Accurately measure the performance of a TDOA wireless location system and determine its ability to locate wireless E9-1-1callers, including the number of receivers required.
- Based on actual field use, identify any system improvements needed before planning for full state-wide operational systems.
- Determine the technical system integration required between the many participants in the trial.
- Determine the impact that a wireless enhanced 9-1-1 system would have on the existing 9-1-1 communications network.

- o Determine the impact of the wireless E9-1-1 system on PSAP operations.

- o Collect anecdotal and statistical evidence useful in determining the value of wireless E9-1-1 systems to callers in actual emergencies.

B. Trial Participants

There was a broad range of support and cooperation between private industry and State of New Jersey public agencies. Listed below are the participants of the trial:

Government Agencies
Department of Law and Public Safety
Division of State Police
Office of Emergency Telecommunications Services (OETS)
Camden County Department of Public Safety
Gloucester County Department of Public Safety
Salem County Department of Public Safety

Companies	Product and/or Service Provided
The Associated Group/TruePosition, Inc.	TruePosition Wireless Location System
Comcast Cellular Communications	Cellular Network
Bell Atlantic - New Jersey	9-1-1 network communications
SCC Communications	9-1-1 selective routing
Rockwell Telecommunications	9-1-1 tandem switch
KML Technologies	PSAP terminals
MapInfo	Electronic mapping programs
On-Target Mapping	Electronic map data
QED	Electronic map data

III. Technology -- How it Works

A. Location Technology - TruePosition System

There are over 25,000 cell sites in the U.S. today, but wireless communications networks are designed so that a mobile telephone uses only one cell site at a time. These systems are very efficient for placing calls, but current receivers are not capable of determining an emergency caller's exact location.

The TruePosition Wireless Location System relies on advanced location receivers added to existing cell sites. The signals transmitted by a cellular phone during a 9-1-1 call are collected by the TruePosition receivers at three to eight different cell sites. The TDOA technology used by TruePosition is the same technology used in the Global Positioning System (GPS) and in many radar systems. TDOA relies on a precise timing of the signals sent by a mobile phone during the start of a 9-1-1 call. The signals travel at the speed of light in many directions from a telephone. TruePosition measures the difference in times the signals reach different receivers, using techniques accurate to billionths of a second. The data collected by these receivers are then combined in a central processing system to calculate an emergency caller's location. Typically, the location is displayed on an emergency dispatcher's computer map terminal before the call is even answered.

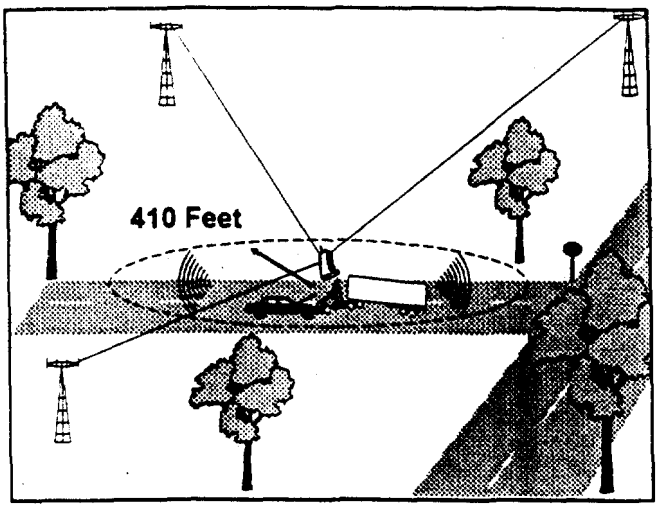

Figure 2 - Location Technology At Work

The use of TDOA technology at cell sites means that no wireless telephone will need to be changed, including the 46 million wireless telephones in use today in the U.S. Technology upgrades are needed only at cell sites, and users of wireless networks can keep the mobile telephones they already own and still obtain the benefits of E9-1-1.

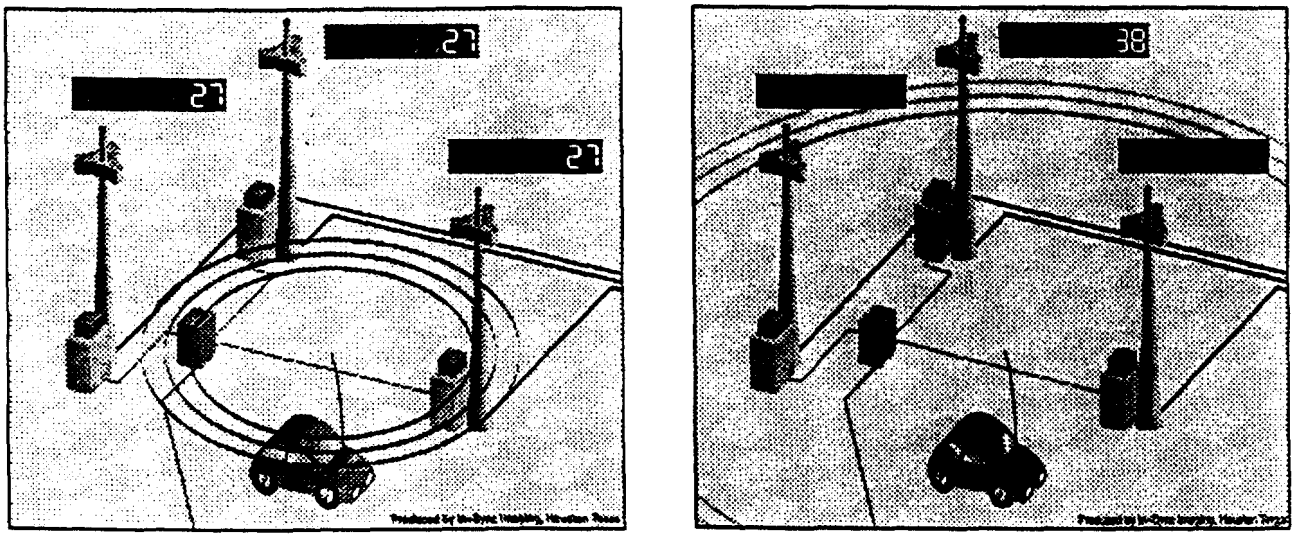

Figure 3 – Model of Time Difference Of Arrival Location System

B. E9-1-1 Call Routing Technology

Enhanced wireline 9-1-1 systems today provide a unique feature called Selective Routing. This feature allows 9-1-1 calls to be delivered to the correct PSAP based upon the location from which the call originated. Call routing for each individual telephone number is pre-determined based on address/location information supplied by the local exchange carrier and the emergency response agencies. Call routing and address/location information is updated to databases that are then available for live 9-1-1 call processing. All initial database

creation and ongoing maintenance is performed administratively in background modes. A significant challenge to implementation of a Phase II wireless E9-1-1 solution is the application of coordinate based location information to the proper routing of a 9-1-1 call.

In a wireless network, it is not possible to pre-determine the source location of a 9-1-1 call because the communication devices are always moving. For this reason, the traditional Master Street Address Guide (MSAG) and pre-processed relational files cannot be used. A geofile or map base must become the backdrop for routing decisions. As a coordinate pair is received from the location system, it is electronically plotted against the geofile to determine its relationship to PSAP boundaries. Routing instructions are dynamically created in real time and provided to the E9-1-1 network during the call set up process. The coordinate data is then used dynamically to create an ALI record for distribution to the appropriate 9-1-1 call taker.

Selective Routing technology for the New Jersey Wireless Enhanced 9-1-1 System trial was jointly provided by Bell Atlantic, Rockwell Telecommunications, and SCC Communications Corporation.

SCC provided their SR/ALI platform, with their Dynamic Call Routing (DCR) feature. The DCR application uses a "Point in Polygon (PiP)" routine for dynamically calculating the Emergency Service Number (ESN), which is used to provide routing instructions to the Rockwell E9-1-1 tandem switch. The creation of a dynamic ESN is the result of matching the X,Y coordinate location of a calling party with an ESN polygon layer in the PiP routine of the DCR application. This information is then provided to the SR/ALI platform where network call routing instructions and ALI records are dynamically created.

Bell Atlantic's E9-1-1 tandem switch, supplied by Rockwell, has the advanced capability of querying an external system for routing instructions. Using this real time interface, the Rockwell SCX queries the SR/ALI system for 9-1-1 call routing instructions and receives the ESN information that was dynamically created using the wireless caller's location data.

This process allows wireless 9-1-1 calls to be delivered to the correct PSAP with location information to support an appropriate emergency response.

C. An Integrated Wireless Enhanced 9-1-1 System Design

When a person makes a wireless emergency call, information is simultaneously sent through two routes to complete both phases of an E9-1-1 call. The caller's voice, 10-digit wireless phone number (Automatic Number Identification) and information about the nearest cell site (Pseudo-Automatic Number Identification) initiating the call are routed through Comcast Cellular's base station (BS in the following diagram) and Mobile Switch Center (MSC). This information is then passed by Comcast to the Local Exchange Carrier (LEC), which in this case is Bell Atlantic-New Jersey. Bell Atlantic routes the information to the Rockwell 9-1-1 tandem (9-1-1 in the diagram).

The KML PSAP terminal provides each dispatcher with a toggle switch key to display the text version of a caller's information (phone number and location) and/or graphical mapping information with the caller's location prominently displayed. MapInfo provided electronic mapping programs for the trial and On-Target Mapping and QED provided electronic map data.

IV. Trial Results

A. Emergency Calls to PSAPs

1. Total Calls Located

The TruePosition location system provided location reports for 3,505 actual wireless E9-1-1 callers from January 22 to April 30, 1997. This includes both local customers and visitors traveling from another area. Over the entire period, an average of 35 wireless E9-1-1 callers per day were located, but the actual number of calls per day and per week varied based upon weather and other factors. On the bar graph below, the number of wireless E9-1-1 callers located during each week of the trial is shown along the vertical axis, and the data on the horizontal axis represents a 7-day period beginning on the date shown, except for the first and last weeks, which were shorter in length.

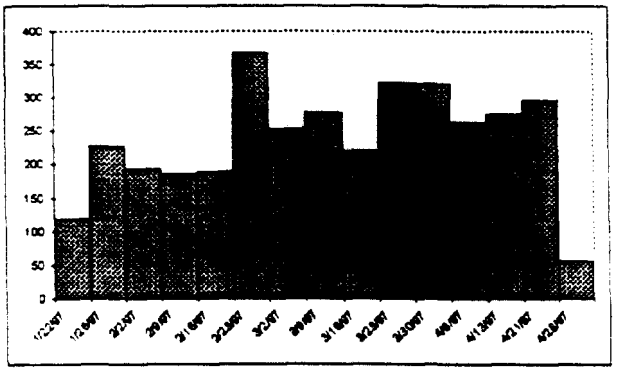

Figure 6 – Number of Located Wireless 9-1-1 Calls per Week

A plot of all wireless E9-1-1 callers located by the location system is shown below:

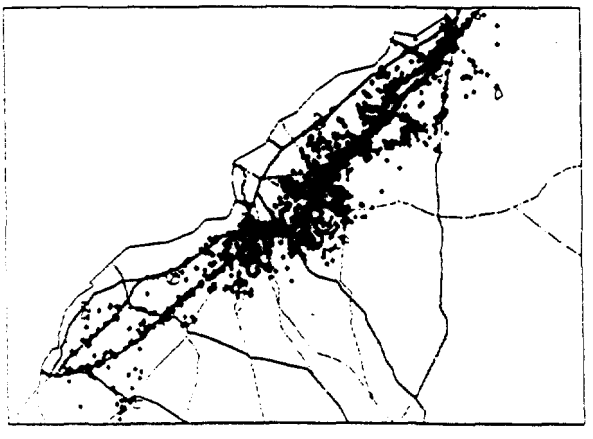

Figure 7 – Plot of All Wireless 9-1-1 Calls Located by TruePosition

Each diamond on the diagram represents a single location estimate for a single 9-1-1 call from a subscriber using the Comcast Cellular network. Because there were so many location estimates performed by the system, some of the map appears completely filled. Therefore, the following statistics are useful to understanding the profiles of these wireless E9-1-1 callers.

2. Specific Locations of Callers

The locations of the wireless E9-1-1 callers were analyzed to determine where emergencies occur. The 3,505 wireless E9-1-1 calls were grouped into four categories:

1,833 (52%) of emergency calls came from interstate highways, such as the New Jersey Turnpike, the Pennsylvania Turnpike Extension into NJ, and I-295.

896 (26%) of emergency calls came from other 4 lane roads and highways that did not have interstate designation, such as Routes 42, 55, 70, 73, 38, 41, and 30. Anecdotal evidence suggests that some of these 4-lane highways may have represented an even greater percentage of emergencies if the coverage area of the trial system had been extended. For example, the portions Routes 42 and 55 within the coverage area exhibited heavy call volume, and PSAP dispatchers indicated that the same call volume also extends outside of the coverage area.

424 (12%) of emergency calls came from major state and county 2 lane roads, such as Springdale Road, Greentree Road, Evesham Road, Route 541, and many others. These are connector roads typically used for commuting and for access to the 4 lane highways.

352 (10%) of emergency calls came from other places, such as residential streets, parking lots, and near or inside buildings.

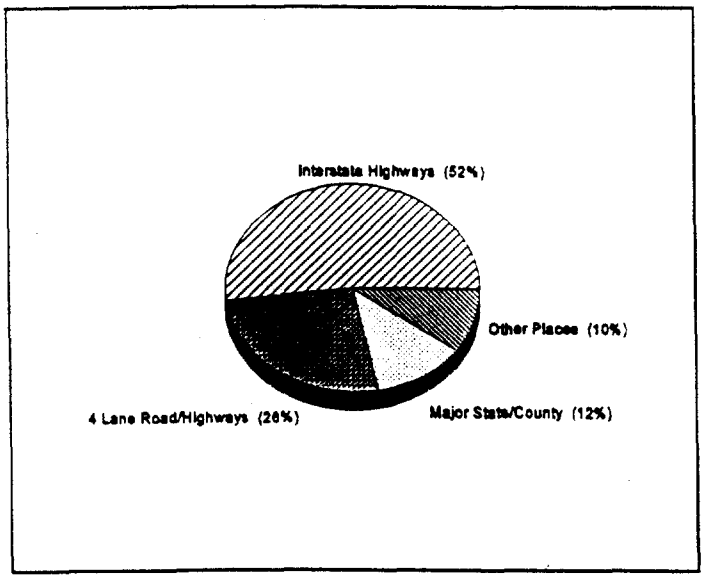

Figure 8 – Specific Location of Wireless 9-1-1 Callers

3. Area Codes of Roaming Callers

The TruePosition system was installed on Comcast Cellular Communications cell sites, and was capable of locating any wireless caller compatible with the Comcast system. Many callers were not local, especially on the New Jersey Turnpike. For example, during one accident that occurred during the trial, five calls were received in rapid succession at the Gloucester County PSAP. Based upon the area codes of the five phones used to make the wireless E9-1-1 calls, none of the callers were from New Jersey, southeastern Pennsylvania, or Delaware. The 3,505 E9-1-1 calls were analyzed to determine the ratio of local and non-local callers:

2,464 (70%) of the emergency callers were from southern and central New Jersey (phone numbers beginning with area codes 609 and 908).

103 (3%) of the emergency callers were from northern New Jersey (area code 201).

521 (15%) of the emergency callers were from Pennsylvania (area codes 215 and 610)

44 (1%) of the emergency callers were from Delaware (area code 302).

373 (11%) of the emergency callers were from other area codes.

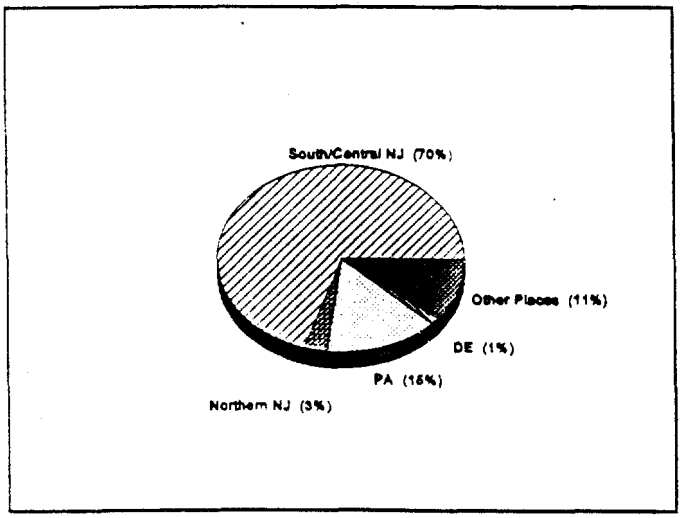

Figure 9 – Area Codes of Roaming Callers

Thus, 30% of the wireless E9-1-1 callers were not local. There was not sufficient anecdotal data collected to determine whether callers from "out of town" were less familiar with their surroundings, and perhaps more likely to require the assistance of location technology to determine their exact location.

In addition to the 3,505 wireless E9-1-1 callers located by the Phase II location system, an additional 1,697 wireless E9-1-1 callers were served by the Phase I (number identification) portion of the trial system. These callers were not within the coverage area of the TruePosition system, and so could not be located. Even though the callers were outside of the location coverage area, the caller's callback information (ANI) and the cell site could be determined from the Phase I ANI/pseudo-ANI reporting from the cell sites involved in the trial area.